5E Lesson call-out box

The 5E lesson outlined below is intended as a learning experience that took place over several class periods. We have also included detail on other vital teaching considerations such as assessment, differentiation and classroom management to help middle school science teachers best implement similar learning experiences in their classroom. Please see *Table 3* for how this 5E learning experience aligns with specific elements of the science with a commitment to community framework.

**Engage:** To ***engage*** her students with the science with a commitment to community framework in mind, Ms. L. challenged students to engineer a design to foster a “happy and healthy classroom environment”. The students had been learning about engineering design practices, energy transformations, and circuitry and this challenge asked students to draw upon these areas as well as what they know about their community.

*Teaching considerations:* After the challenge is issued, students can brainstorm in pairs what types of issues they would like to try to solve. It might be helpful to talk through an example before setting groups off to brainstorm. For example, Ms. L talked about how her students in the previous year were concerned about the challenge of helping all of the students to feel accomplished. After pair brainstorm, make sure to publicly document student ideas. Make sure to let students know that there are no wrong answers and risk taking is valued (this can be done by praising individual students as well as letting the class know that critique of ideas will not be tolerated at this stage). The students’ ideas publicly documented can be used to create surveys. Assessment at this time is formative as the teachers notices what students identify as important to their classrooms and lived lives.

**Explore:**

Ms. L. planned for two opportunities for students to ***explore*** to build further understanding of community insight as well as related science knowledge and practices. These areas of expertise are both positioned as vital to draw upon to design to foster a happy and healthy classroom environment.

*Explore 1:* To ensure community voice in incorporated into projects, Mrs. L. asked students to design, administer and analyze community data related to the problems they identified. Students should be encouraged to use the analyzed data to make evidence-based claims about the issues that impact their classroom communities.

*Teaching considerations:* Students might have many great ideas to ask about in their surveys, but not might have a lot of experience creating surveys and looking at results. Share some examples (both good and not as good) with them and have small groups investigate what kinds of data the questions would provide and would that data be helpful to their projects. Once students are ready to create their own surveys, groups should be kept to four students or less. Ms. L let her students choose groups based on interest in the topic which impacts how and why the issue matters to students. Students can also test their survey by asking other students in class to complete which offers space for revision before asking the larger community. Once data is gathered, once again model how to analyze data before setting groups off to complete on their own. Assessment of students in this section is based on skill development related to standards MS-ETS1-1 and MS-ETS1-4.

*Explore 2:* Next, students used analyzed data from the community survey and knowledge of energy transformation to sketch up realistic design solutions.

*Teaching considerations*: Make sure students understand (and document) that the design process requires multiple iterations before a design solution can be decided upon. Also, make sure students brainstorm about materials needed (even if students are asked to design from a pre-determined list of materials). Provide opportunities for feedback from peers, teacher, community members and/or “outside experts”. This way students can evaluate and improve designs. Be present in groups as they work on designs to help them reflect on both community data and understanding of relevant science concepts. Assessment during this phase of explore focused on standards MS-PS3-3, MS-ETS1-2 & MS-ETS1-4.

**Explain:** This is the phase of the learning experience where students use what they created in the explore phase to take action on issues that matter to them and their community. Students are asked to reflect on how their creation addresses the issue identified (this could be through student writing, presentations, or other assessment actions). They should explain how the technical and social design dimensions of their project work together to respond to the issue identified in their data. The projects can take various forms. In the example provided from Ms. L’s class, the bank of compliments project featuring four LED lights in parallel circuit powered by handcrank generator filled with over 20 compliments intended to impact both bullies and those that have been bullied. They integrated their science knowledge with what they knew/learned about community concerns. Other groups created a “Mood Board” to help students communicate to their teacher and peers when they are having a difficult day, a light-up “Helping Hands” Board for the main school hallway to allow any school member to light-up inspirational messages when they needed a “pick-me-up” and the “no-knock doorbell”, a light-up system to let the class know when someone wants to enter the classroom.

*Teaching considerations:* This section of the learning experience may seem chaotic, but a few considerations will assist in students staying focused on the task at hand and your classroom being ready for your next class. First, remind students to work from the design they created in the explore phase. That design should have drawings and a materials list to follow. Second, have regular check ins with groups to track progress, help through any areas where students get stuck and to focus the work going forward. Finally, make sure time is built in for cleaning up the build site area and reflecting on the progress of the day.

**Extend:** This is the aspect of the class and small groups reflect on 1) where else their issue and solution matter and 2) how they can use their skills and expertise to impact the issue in their community. In the example provided, the injustices of bullying became a legitimate science-related issue that could be acted upon beyond their classroom and spread into the larger school community

*Teaching considerations:* Provide structure for reflecting on the impact of their projects. This could take the form of individual writing prompts, peer interviews, or other creative ways for students to reflect on extending their knowledge and skills to other spaces in their community.

**Evaluate:** As with all learning opportunities, the teachers should always assess their students in terms of their skill development, content knowledge, and interests/areas of expertise/motivations of their students. The opportunities for formative assessment during this learning experience are multiple. In particular, the teacher evaluates the ways in which students used multiple areas of expertise to impact local conditions, as well as her/his role in support such learning.

This learning opportunity also provides space for students to assess their own knowledge, skills, actions and identities. In particular, students evaluate whether their actions produced the types of transformative outcomes they desired, and whether the inclusion of other perspectives may have impacted their project.

**Standards addressed:**

MS-PS3-3 Energy Transfer: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer

MS-ETS1-1 Engineering Design: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Engineering Design: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem

MS-ETS1-4 Engineering Design: Develop a model to generate to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.